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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 12 25TH MAY, 1956 PART 3

THE BIONOMICS AND IMMATURE STAGES OF THE THISTLE LACE BUGS (*TINGIS AMPLIATA* H.-S. AND *T. CARDUI* L.; HEM., TINGIDAE)

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INTRODUCTION

Two species of *Tingis* are found on thistles in Britain and the following notes give descriptions of the larval instars, most of which have hitherto been undescribed, together with information on host plants and distribution. Most previous work has simply recorded the species from "thistles." This has obscured a marked difference in host relationship, for they occur respectively on different species of thistle and occupy quite distinct regions of the plant. Just before, during and after hibernation they may be found on plants other than thistle, but this association is fortuitous.

Tingis ampliata Herrich-Schaeffer

Host Plant

Reclaire (1940) and Cobben (1948) associated this species with the Creeping Thistle (*Cirsium arvense* (L.) Scop.) and this has been our experience. Singer (1952) also records it from this species and from the Marsh Thistle (*C. palustre* (L.) Scop.).

The eggs are laid in the stem of the thistle, usually in the upper part. The young larvae are generally found on the vegetative or axillary buds; they do not move much before the fourth instar, for empty skins of earlier stages and the larva itself are often found close together. The fourth and fifth stage larval move along the leaves away from the centre of the bud and may be found often on mature leaves. The adults occur on all parts of the plant, but are very seldom found on the involucre.

These generalisations are illustrated by observations made on September 2nd, 1954, when the distribution of a colony of *T. ampliata* on plants of *C. arvense* on Harpenden Common, was recorded (fig. 1).

It was found in the laboratory that when the larvae were placed on the involucre they would always move off and if confined to this region they died.

Life history and population estimate

All available evidence points to this species being univoltine in this country; Singer's (1952) records suggest that the same is true for Germany.

The adults overwinter amongst moss and litter at the roots of plants. In early May they colonise creeping thistle and soon aggregate into localised colonies on the thistles; why a particular group of plants should be the site of the colony is not known. On September 2nd, 1954, in such a group of 71 plants on Harpenden Common, *T. ampliata* was found on 65 plants; but it was absent from similar adjacent groups of plants.

During 1953 an experiment to estimate the population size by marking was made; the results are appended (Table 1). A colony of *T. ampliata* was found on eight plants of *C. arvense* growing in some waste land at Rothamsted. On four occasions these plants were searched and every *T. ampliata* adult seen was removed and marked with cellulose paint; a

Table 1

The results of the population estimation by marking and recovery

	June									July		Aug.
	4	8	10	12	15	18	22	25	29	14	22	6
Total collected.. ..	33	26	37	24	36	32	23	32	19	1	1	1
Number previously unmarked	33	8	14	14	16	4	4	9	2	–	–	–
Number previously marked	—	18	23	10	20	28	19	23	17	1	1	1
Number recovered with mark of June 4th ..	—	18	17	7	13	16	11	14	6	–	–	1
Number recovered with mark of June 8th ..	—	—	18	7	11	12	11	10	4	–	1	–
Number recovered with mark of June 15th ..	—	—	—	—	—	16	12	18	9	1	–	–
Number recovered with mark of June 25th ..	—	—	—	—	—	—	—	—	12	–	–	1
Total marked	33	26	—	—	36	—	—	32	—	–	–	–

different coloured paint and different marking position (on hemielytra or pronotum) being used each day. The lace bugs were then returned to the plants. On other days the total numbers were counted *in situ*, but none was marked.

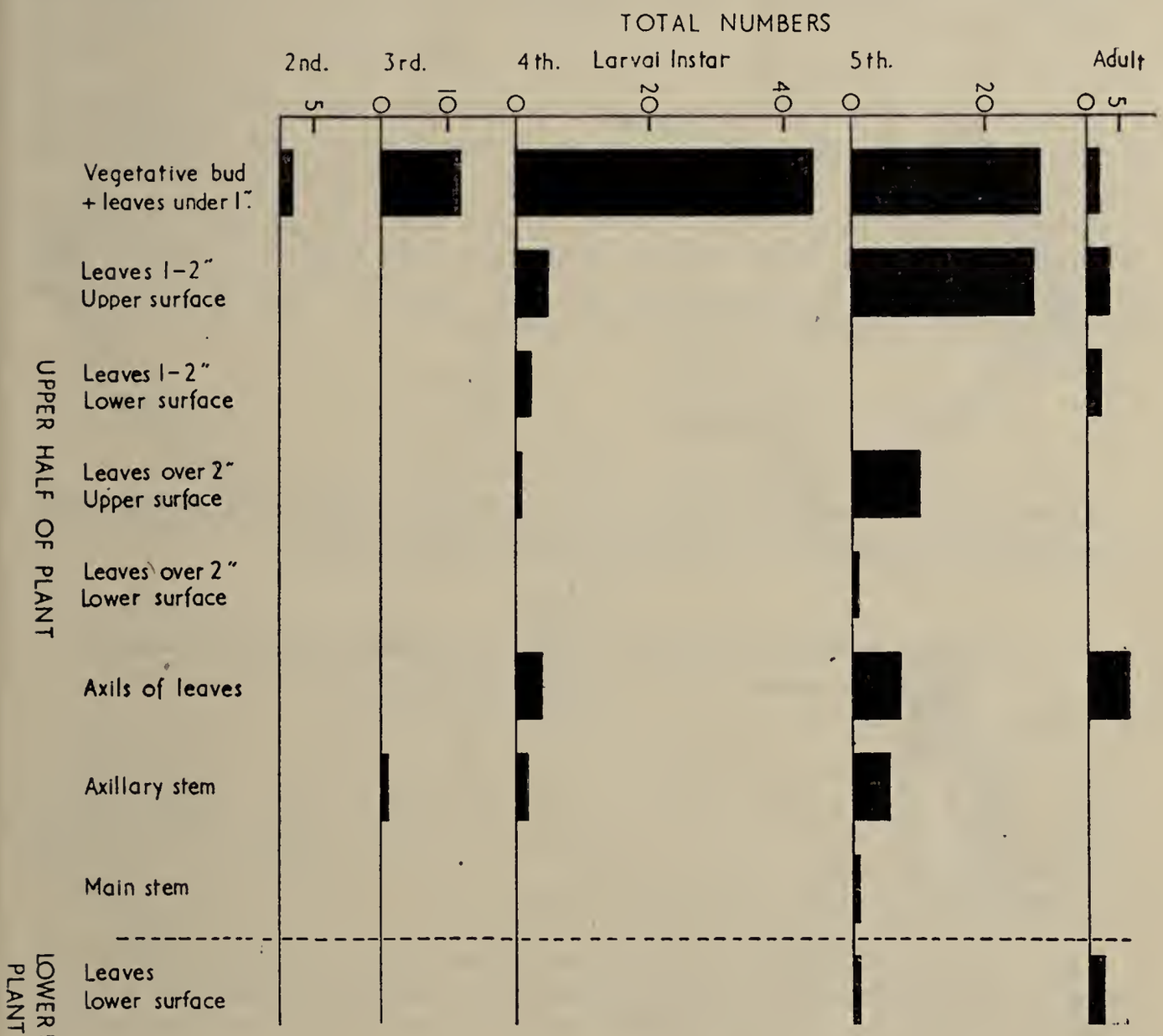

Fig. 1. The distribution of the various stages of *T. ampliata* between different regions of the host plant, *Cirsium arvense* (based on observations on September 2nd).

NOTE.—*T. ampliata* was completely absent from the involucre and most of the lower half of the plants.

TABLE 2

The estimates of total population, using a simple Lincoln Index, with their standard errors

Recaptured	Marked on			
	June 4th	June 8th	June 15th	June 25th
June 8th	48±4·2	—	—	—
June 10th	72±8·9	53±5·0	—	—
June 12th	113±31·9	89±24·2	—	—
June 15th	91±15·7	85±16·2	—	—
June 18th	66±8·4	69±11·6	72±9·5	—
June 22nd	69±12·3	54±9·0	69±11·2	—
June 25th	75±11·4	83±17·1	64±7·1	—
June 29th	104±31·8	124±50·6	76±15·9	51±7·0

If simple Lincoln Index estimates* are made of the population (N) on the days of marking, using each recapture total, a series of values is obtained Table 2). Each of these values represents:

$$N+\frac{B}{q}$$

where B=total births and immigration, and q=survival rate during the period between marking and recapture; since there are no births at this time of year we can consider B as equivalent to immigration.

From these figures (Table 2) it would appear that the population remained fairly constant from June 12th to June 25th, but that on June 8th and probably on June 10th immigration was still occurring. If these populations are estimated by maximum likelihood they are:

June 8th $=48\pm4{\cdot}2$

June 10th $=66\pm5{\cdot}6$

June 12th - 25th $=73\pm3{\cdot}8$

Although the estimates for June 10th and June 12th - 25th do not differ significantly, it still seems advisable to keep them separate.

TABLE 3

The actual recaptured compared with the estimated values (in parenthesis)

Marked	Total	Recaptured on June						
		8	10	12	15	18	22	25
June 4th	33	18 (18·0)	17 (18·5)	7 (10·8)	13 (16·3)	16 (14·5)	11 (10·4)	14 (14·5)
June 8th	26	—	18 (14·6)	7 (8·5)	11 (12·8)	12 (11·4)	11 (8·2)	10 (11·4)
June 15th	36	—	—	—	—	16 (15·8)	12 (11·3)	18 (15·8)
Unmarked		8 (8·1)	14 (14·0)	14 (10·5)	16 (15·8)	4 (7·0)	4 (5·0)	9 (7·0)

Using the above estimates of total population it is possible to obtain the expected recaptures; these are compared with the actual values in Table 3. Owing to the lack of independence of some of the data, an exact test of goodness of fit is precluded, however it is evident that they are reasonably close and therefore the statistical evidence supports the biological assumptions. These are that up to the end of the first week in June the population was increasing from immigration; but that for the next three weeks, the period of maximum egg laying, the population remains constant; in this case an average of nine per plant. After June 25th the population starts to decrease, owing to deaths; the recaptures subsequent to this date have been ignored as the extra information would not warrant the additional complication in mathematics. The last overwintered adult (a female) to be found was taken on August 6th, by then the new generation was beginning to mature.

Copulation was observed frequently from June 4th - 25th, 1953; the male was always dorsal, with an angle of about 35° between their longitudinal axes. Most commonly, but not invariably, the male was to the right of the

* Estimate of total population $=\dfrac{\text{Total second catch} \times \text{Total number originally marked}}{\text{Total number of marked individuals recaptured in second catch}}$

female. Unsuccessful attempts at copulation were frequently seen, especially towards the end of June. The first eggs were found on June 4th and the last on July 23rd (it hatched the following day), by which time the larvae of all instars were present in the colony. The first adult was found on August 8th, when the youngest larva was in the third instar and the great majority were in the last instar.

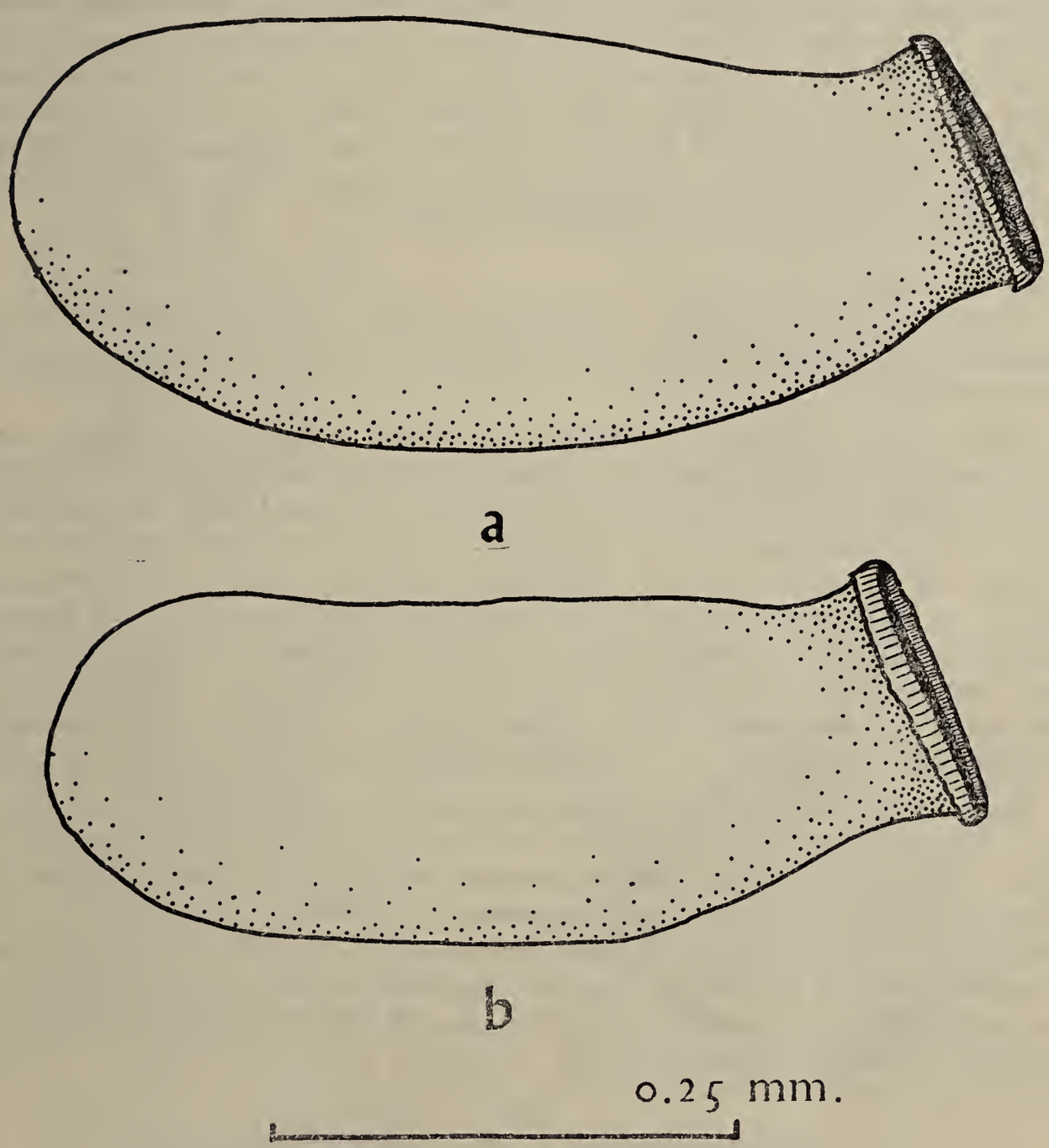

Fig. 2. a, *T. ampliata*, egg; b, *T. cardui*, egg.

In 1954 another colony of *T. ampliata* was found on *C. arvense* growing on Harpenden Common. When the colony was discovered on August 12th two adults (judged to be overwintered by the "rubbed" appearance of the surface wax, lack of fat body and atrophied gonads) were present, together with a large number of larvae mostly in the third and fourth instars, although three were in the fifth. The colony was observed frequently and the first new adult was found on August 16th, a week later than in 1953. However the great difference between colonies in 1953 and 1954 lay in the great scatter of individual life histories during the season, for some first instar

larvae were also found on August 16th and the last larvae did not mature until October 3rd, when many of the thistles were dying and some of the larvae probably perished from starvation.

We may now summarise the normal life history. The adult stage is reached between the second week in August and early September; these adults overwinter and return to *C. arvense* in the following spring when colonies are formed. In late May oviposition starts, continuing for about six weeks; during the egg laying period the numbers in the population remain fairly constant. The overwintered adults begin to die at the end of June and only a few remain by the second week in August when the earliest of the new generation, which hatched from the eggs at the end of June, are maturing.

Larvae were kept both singly and together in the laboratory. The duration of the later instars varied considerably (Table 5).

Egg (fig. 2A)

Average length 0·56 mm., maximum width 0·22 mm. White with a distinct slightly brown operculum; surface of chorion with minute hexagonal reticulations.

Oviposition: The eggs are imbedded, usually singly, in the thistle stem with only the operculum and rim of the chorion projecting above the surface. The surrounding plant tissue was frequently brown and hard, but sectioning showed that this was due to damage to the plant tissue and not as in *Stephanitis rhododendri* How. (Johnson, 1936), to corky gall formation. Faeces were usually present on or near the operculum, this is a frequent feature in Tingids (Leston, 1954) and other heteropterous eggs. Although the direct cause of these deposits may be pressure changes in the posterior region of the abdomen during oviposition, they provide a mechanism in Pentatomids and others for the transmission of symbionts (Carayon, 1952).

Egg Parasite: In 1953 two eggs were found to be parasitised by a Mymarid; this was apparent several days before hatching as a typical compound eye was visible through the chorion, instead of the five separate facets of a Tingid larva. One parasitised egg was preserved in alcohol; the other produced a male which died while still teneral. Dr. W. D. Hincks kindly identified it as a species of *Anaphes*; in view of the condition and sex of the material he was unable to be more precise. This appears to be the first record of a Mymarid parasitising a Tingid.

TABLE 4

Tingis ampliata H.-S. Measurements in mm.
(Each value is an arithmetic mean based on five individuals)

Instar	Length of body	Length of antenna				Length of hind femur	Breadth of head	Greatest width of body
		Seg. 1	Seg. 2	Seg. 3	Seg. 4			
I	0·81	0·05	0·04	0·07	0·10	0·17	0·21	0·42
II	1·06	0·07	0·05	0·10	0·11	0·24	0·27	0·58
III	1·59	0·08	0·06	0·13	0·17	0·32	0·36	0·86
IV	2·23	0·11	0·08	0·21	0·23	0·52	0·46	1·25
V ♂	2·98	0·21	0·11	0·34	0·30	0·68	0·56	1·64
♀	3·12	0·20	0·11	0·33	0·30	0·68	0·58	1·71

Larvae, Description of Stages

The diagnostic measurements are given in Table 4.

First Instar (fig. 3A): Pale fawn, with underside pale, tip of rostrum, apices of tarsi and paired lateral areas on the dorsum of each segment (except posterior) dark brown, dorsal abdominal glands orange; covered with glandular hairs on the upper surface as in fig. 9; shorter hairs are present on the undersurface and form a ring round the anus; eye red with five facets.

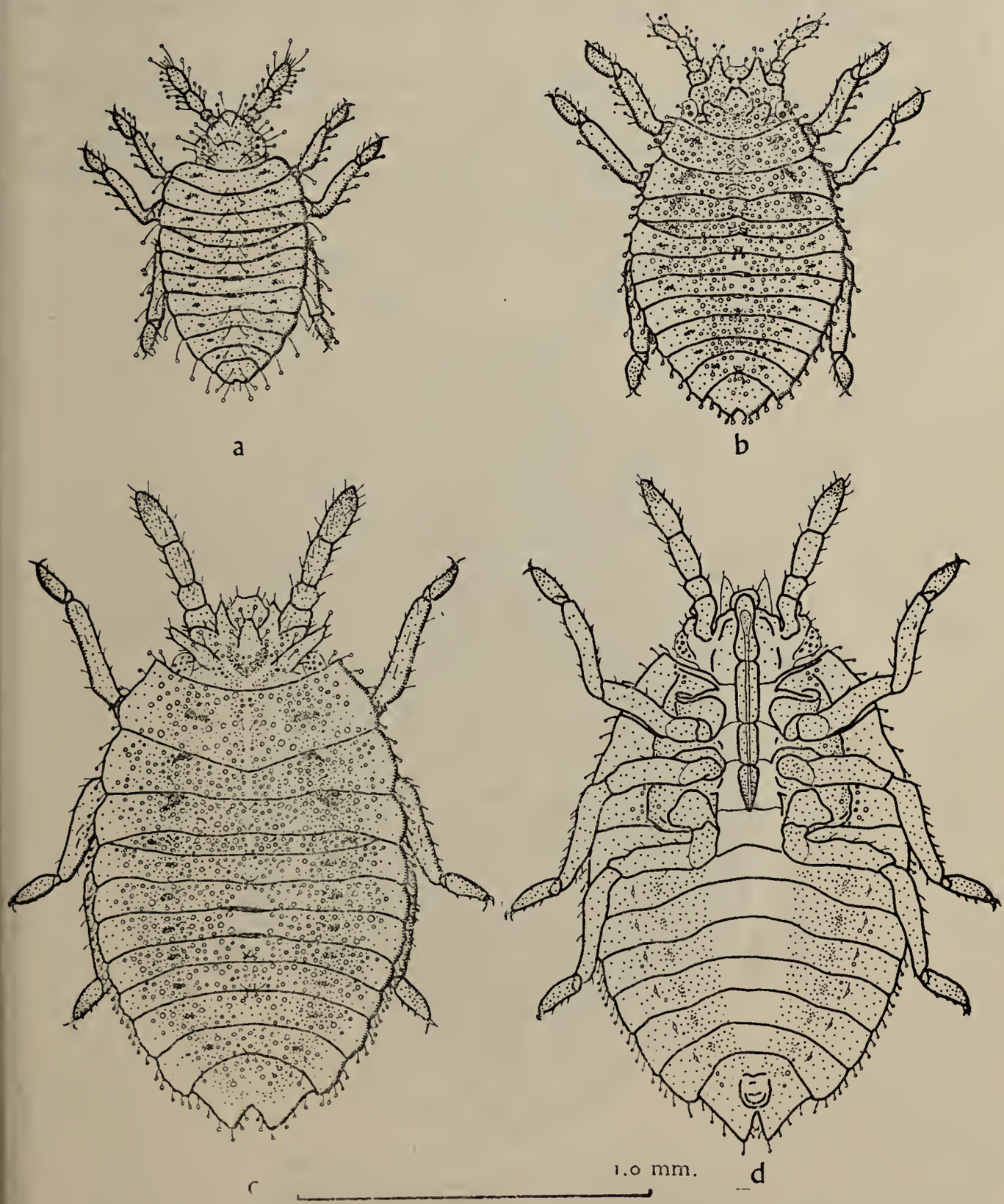

Fig. 3. *T. ampliata*, larvae: *a*, first instar; *b*, second instar; *c*, third instar; *d*, third instar (ventral view).

Second Instar (fig. 3B): Pale olive brown, with underside lighter except for a very pale central area (as in third instar, fig. 3D); whole of upper surface covered with pale tubercles; Y-shaped mark on head, the stem of this mark continues down the centre of the thorax and abdomen on to segment 2; tip of rostrum, apices of last segment of antennae and tarsi, paired lateral areas on the dorsum of each segment (except posterior) and areas around spiracles dark brown; dorsal abdominal glands orange; gut contents often visible; hairs shorter than in first instar; eye red with five facets; slight warts developing around base of glandular hairs on median of abdominal segments 2, 5, 6 and 8.

Third Instar (figs. 3C, 3D): Pale brown; pale and dark areas as in second instar, except for the dark U-shaped area on the vertex which is now distinct; dorsal abdominal glands orange; hairs short, but fairly numerous; eye red with fifteen facets; warts on median of abdominal segments 2 and 5 slightly lighter than those on 6 and 8 which are pale brown.

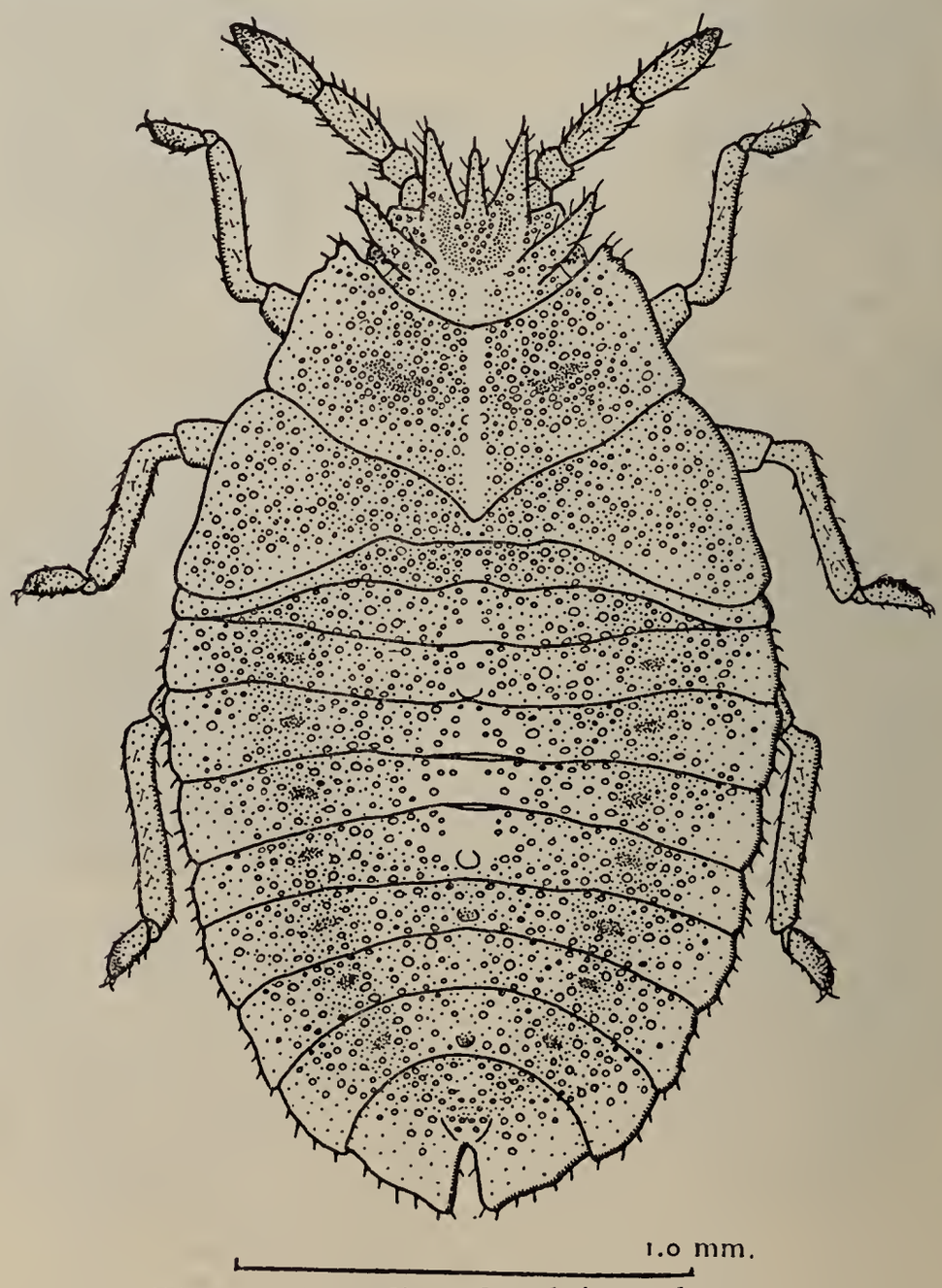

Fig. 4. *T. ampliata*, fourth instar larva.

Fourth Instar (fig. 4): Pale brown, pale areas as in third instar; the dark areas are darker, but with the same distribution as in the third; dorsal

abdominal glands orange; globule no longer distinct on the apex of the glandular hairs; eyes red with about twenty facets; warts pale brown (general ground colour); wing pads now clearly visible.

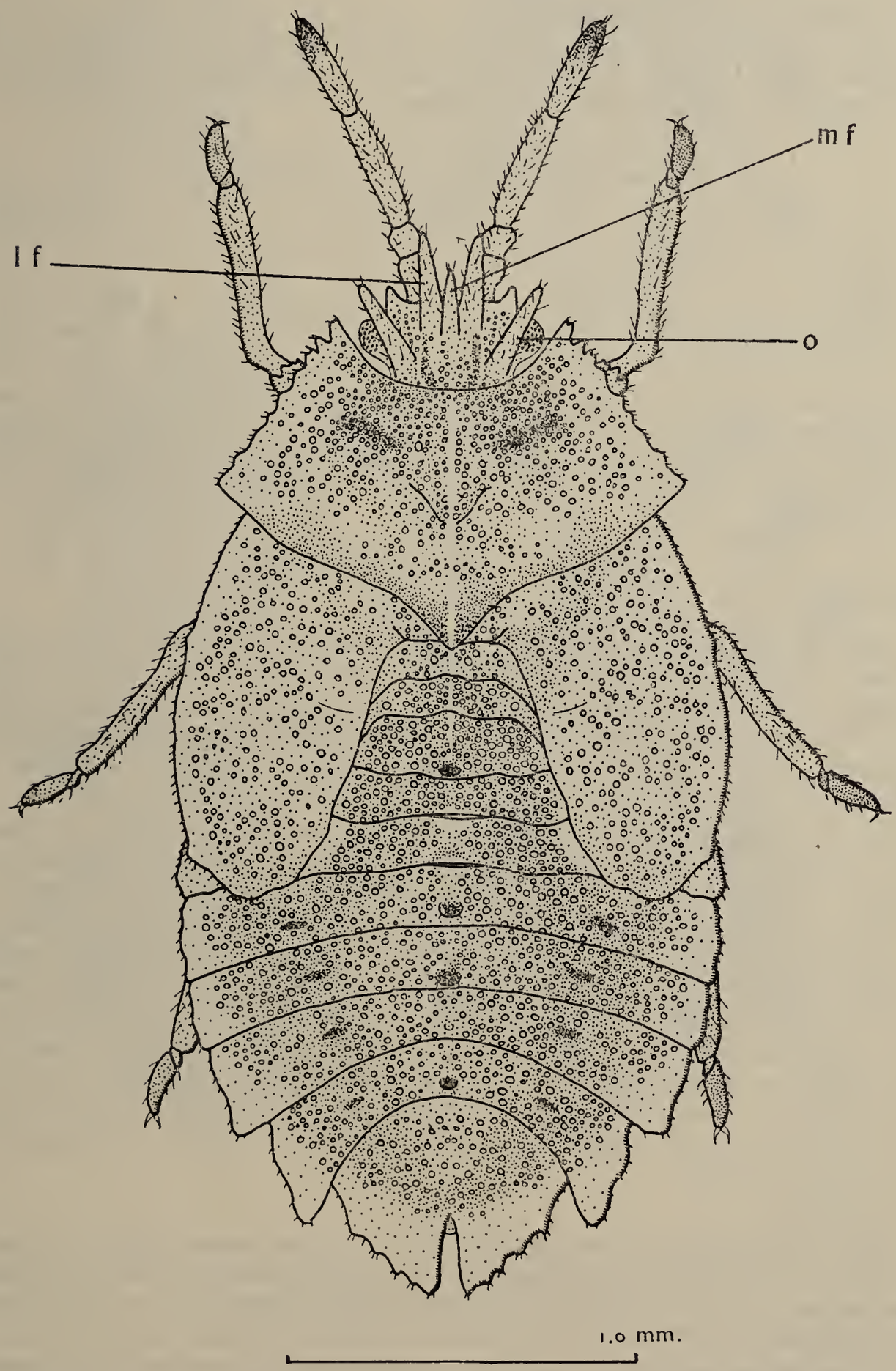

Fig. 5. *T. ampliata*, fifth instar larva. lf=lateral frontal process, mf=median frontal process, o=occipital process.

Fifth Instar (fig. 5): Brown (darker than fourth); pale and dark areas as in fourth; dorsal abdominal glands orange; eyes red with about forty-eight facets; warts on median of segments 2, 5, 6 and 8 dark brown; wing buds just reaching 5th abdominal segment.

The 5th instar larva is described by Butler (1923), his "tubercles" correspond with "warts" in this paper; minor protuberances on the cuticle are described as "tubercles" in this paper.

TABLE 5

Duration of instars in days (*=range)

	Tingis ampliata				*Tingis cardui*	
Instar	II	III	IV	V	IV	V
Mean	8·6	8·4	10·0	14·3	7·7	12·5
Standard deviation..	8–9*	1·4	2·6	3·9	7–9*	2·57
No. of individuals ..	3	7	21	20	4	17

Material examined (the figures in parenthesis represent the instars): Rothamsted, Harpenden, Herts., 3/viii/53 (3, 4, 5); Bookham Common, Surrey, 16/viii/53 (5), 4/x/53 (5); Harpenden Common, Harpenden, Herts., 12/viii/54 (2, 3, 4, 5), 14/viii/54 (1, 2, 3, 4, 5), 16/viii/54 (1, 2, 3, 4, 5), 2/ix/54 (2, 3, 4, 5).

TINGIS CARDUI Linnaeus

Host Plant

Mason (1898) was the first to state that this species occurred on Spear Thistle (*Cirsium vulgare* (Savi) Ten.(=*lanceolatus* L.)); Butler (1923), Cobben (1948) and Massee (1954) have confirmed this, though the latter adds "and other species" of thistles. Fieber (1860) recorded it from *Carduus nutans* L. and *C. acanthoides* L. and Strawinski (1954) from the former and *Cirsium vulgare*.

We find that, in Britain, it occurs almost entirely on *C. vulgare*, though it is occasionally found on *C. palustre* (L.) Scop. Unlike *T. ampliata* it is almost confined to the involucre or the region just below; here it is frequently present at a high density, together with aphids and their attendant ants.

In August, 1953 and 1954, colonies were examined in various fields around Flatford Mill Field Centre, East Bergholt, Suffolk. Where only a few plants of *C. vulgare* occurred in a field almost every inflorescence had a colony of lace bugs, although *C. palustre* and *C. arvense* grew close by *T. cardui* was not found on their involucres. In another field at Flatford and also in one at Fawkham, Kent, examined on September 11th, 1954, *C. vulgare* grew abundantly, yet *T. cardui* were only present on scattered plants (c.f. *T. ampliata*, p. 94).

Life History

Butler (1923) quotes Buchanan White who found larvae in June and again in August, he suggests that the species may be bivoltine. We have found last instar larvae in late July and in late August; but this point needs further elucidation.

T. cardui has been taken in flight by suction traps running in the grounds of Rothamsted on three occasions, in late May; seven individuals were caught between May 8th and 12th, 1954, in a large suction trap running in

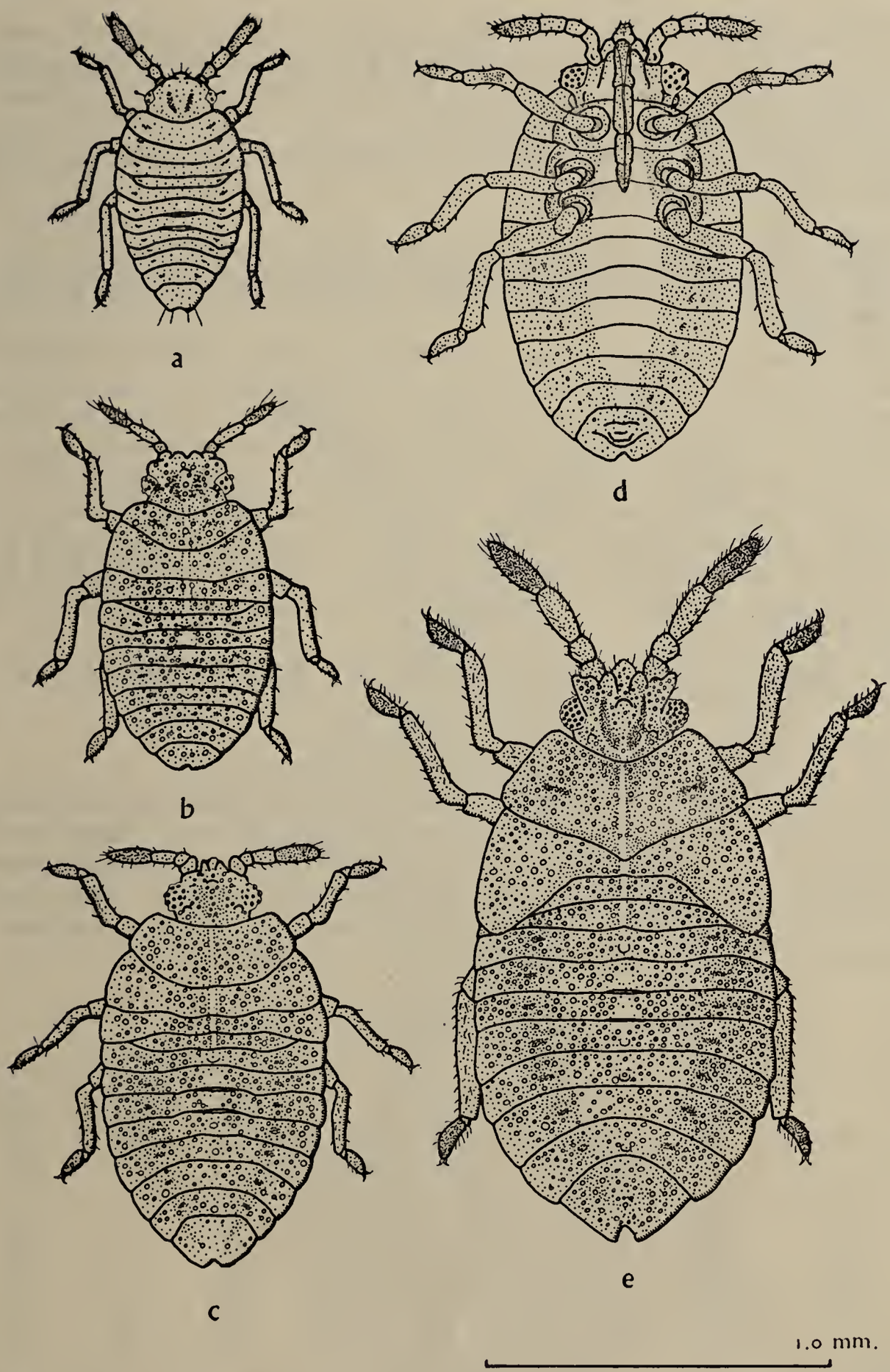

Fig. 6. *T. cardui*, larvae: *a*, first instar; *b*, second instar; *c*, third instar; *d*, third instar (ventral view); *e*, fourth instar.

a wheat field near Harwell, Bucks. It would seem that flight at this time is a dispersal to the biennial host plant after emergence from hibernation. A single specimen was taken in a suction trap at Rothamsted on September 20th, 1954, which would coincide with the death of the thistle plants and

the beginning of hibernation. It is noteworthy that although *C. arvense*, with *T. ampliata*, are far more common at Rothamsted than *C. vulgare* with *T. cardui*; nevertheless *T. ampliata* has never been found in the large number of suction trap catches examined.

The duration of the last two larval instars based on laboratory observations is given in Table 5.

Egg (fig. 2B)

Average length 0·51 mm., maximum width 0·18 mm., white with a distinct pale brown operculum; surface of chorion with minute hexagonal reticulations.

Oviposition: The eggs are laid, usually as singletons, in the leaves, on either side of the midrib. They may be inserted, with only the operculum exposed, in the upper or lower surface, but the leaves chosen are always adjacent to the involucre. On emerging from the egg the larva crawls to the upper surface of the leaf and makes its way to the flowering head. The eggs are usually laid near the tip of the leaf where the felting hairs on the underside are rather sparse. It has been seen that larvae emerging from eggs laid at the centre of the leaf tended to get caught in these felting hairs when walking to the upper surface; one larva died as a result of being trapped in this way.

The use of the leaves as the oviposition site, contrasts with the choice of the stem by *T. ampliata*.

Larvae, Description of Stages

The diagnostic measurements are given in Table 6.

First Instar (fig. 6A): Pale olive brown, underside with pale central area; apical segment of antenna, tip of rostrum and tarsi dark brown; paired lateral areas on dorsum of each segment (except posterior) also dark brown; dorsal abdominal gland orange; eye red, composed of five facets; hairs sparse, but a ring of long hairs is present round anus; tip of apical segment of antenna has distinct group of hairs; no warts or tubercles.

TABLE 6

Tingis cardui L. Measurements in mm.
(Each value is an arithmetic mean based on five individuals).

Instar	Length of body	Length of antenna				Length of hind femur	Breadth of head	Greatest width of body
		Seg. 1	Seg. 2	Seg. 3	Seg. 4			
I	0·68	0·05	0·04	0·06	0·10	0·15	0·21	0·34
II	0·97	0·06	0·04	0·09	0·12	0·21	0·29	0·50
III	1·26	0·08	0·05	0·10	0·14	0·25	0·34	0·69
IV	1·84	0·11	0·08	0·20	0·23	0·43	0·43	0·97
V ♂	2·45	0·16	0·11	0·32	0·29	0·58	0·49	1·19
♀	2·60	0·16	0·11	0·30	0·29	0·57	0·53	1·35

Second Instar (fig. 6B): Dark olive brown, underside paler with a central white mark; upper surface covered with pale tubercles; Y-shaped mark on head, the stem of which continued down the centre of the thorax and abdomen as far as the hind margin of segment 2; tip of rostrum, the apical segments of the antennae, the apices of tarsi, paired lateral areas on the dorsum of each segment (except posterior), and areas around spiracles, dark brown;

dorsal abdominal gland, orange; hairs sparse; eyes red with five facets; slight warts developed on segments 3, 6, 7 and 9.

Third Instar (figs. 6C, 6D): Dark olive brown; with pale and dark areas as in the second instar except for the U-shaped area at the back of the head which is distinct; dorsal abdominal glands orange; hairs sparse; eyes red with about 15 facets; wart on segment 3 pale, those on 6, 7 and 9 dark olive brown.

Fourth Instar (fig. 6E): Dark olive brown; with pale and dark areas as in the third instar; dorsal abdominal glands orange; hairs sparse; eyes red with just over 20 facets; wart on segment 3 pale, others olive brown; wing pads now clearly visible.

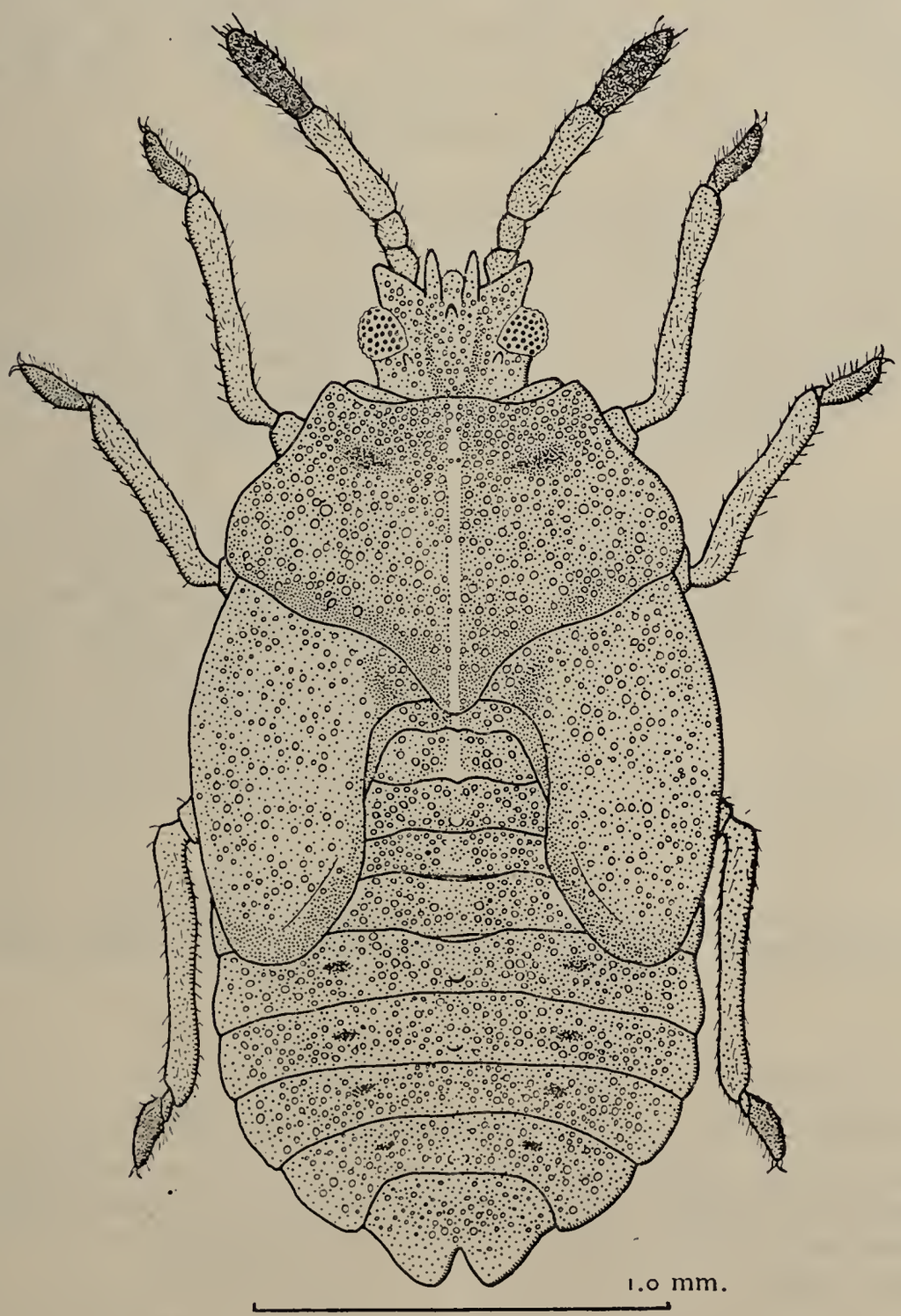

Fig. 7. *T. cardui*, fifth instar larva.

Fifth Instar (fig. 7): Dark olive brown, with markings and coloration as in fourth instar; wing pads extending to the sixth abdominal tergite.

Material examined: (The figures in parenthesis refer to instars). Perrywood Enclosure, New Forest, Hants, 26/vii/50; Flatford Mill, East Bergholt, Suffolk, 30/viii/53 (3, 4, 5), 17/viii/54 (2, 3, 4, 5); Grain, Isle of Grain, Kent, 13/ix/54 (5); Fawkham, Dartford, Kent, 11/ix/54 (4, 5), adults 25/vi/55, egg and first instar bred; Ynyslas, Aberystwyth, Cardiganshire, 17/vii/55 (2, 3, 4, 5); Derwenlas, Machynlleth, Montgomeryshire, 20/vii/55 (2, 3, 4); Tregaron Bog, Cardiganshire, 22/vii/55 (2, 3, 4, 5).

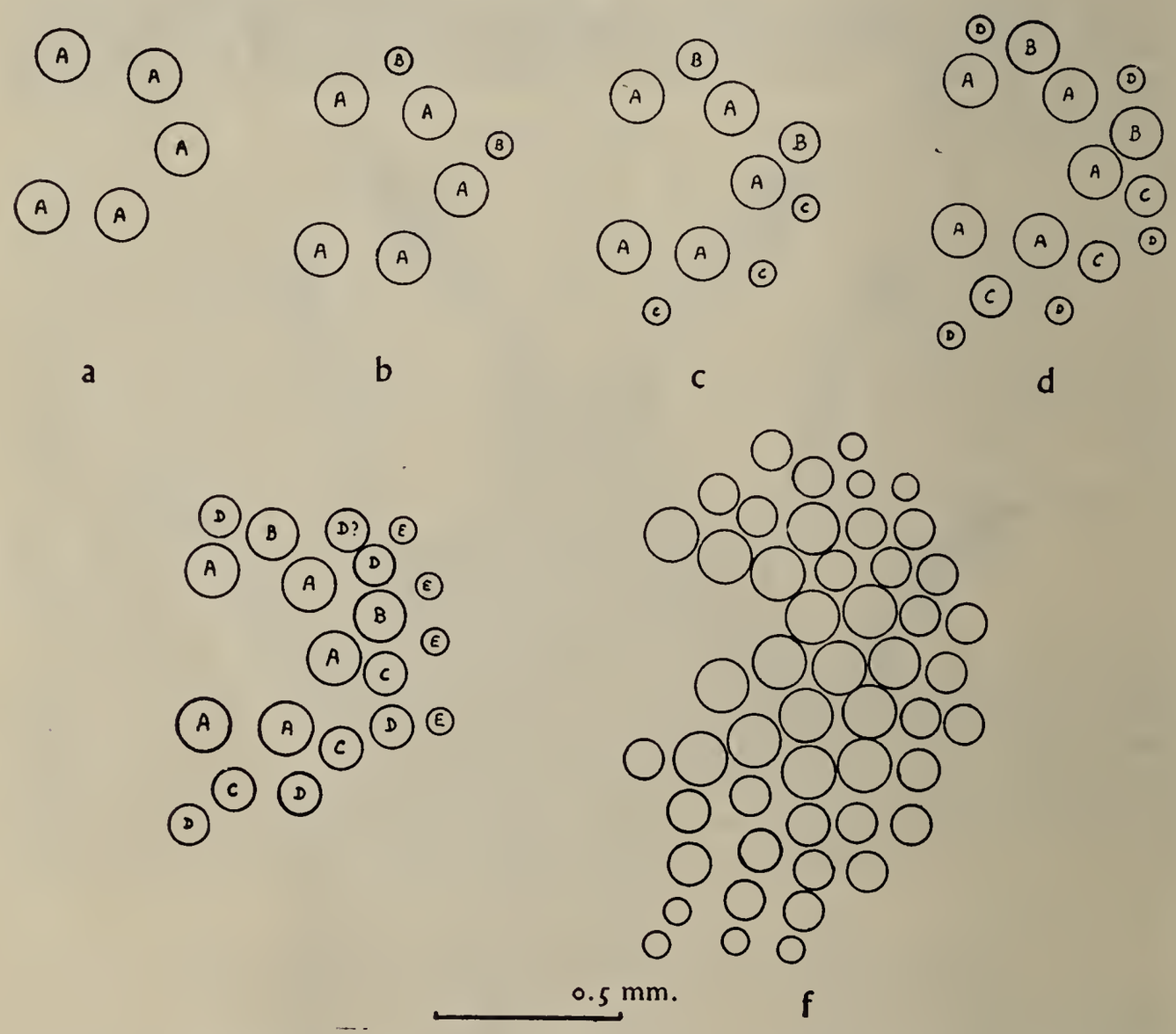

Fig. 8. *T. ampliata*, lateral view right larval eye: *a*, second instar; *b*, third instar, one hour after moult; *c*, third instar, 14 hours after moult; *d*, third instar, mature; *e*, fourth instar; *f*, fifth instar.

Keys to larvae of thistle lace bugs

I *Key to Species*

(The terms used for the head processes are illustrated in fig. 5).

1. Paired frontal processes longer than antenniferous tubercles; median frontal and occipital processes well developed in second to fifth instar, present as protuberances in the first; usually only apex of fourth antennal segment dark ..... *ampliata*
2. Paired frontal processes shorter or (in 5th) only just extending beyond antenniferous tubercles; medium frontal and occipital processes very small and hardly developed prior to the fourth instar; fourth antennal segment entirely dark ..... *cardui*

II *Key to Instars*

1. Eye with five facets (fig. 8A) 2
   Eye with more than five facets 3
2. Thoracic segments all similar in shape; length less than 0·9 mm..... ..... *1st instar*
   Thoracic segments greatly dissimilar, length over 0·9 mm. .. *2nd instar*
3. Wing pads hardly developed (figs. 3C, 6C); eye with about 15 facets (fig. 8D)..... *3rd instar*
   Wing pads well developed (figs. 4, 6E), eye with more than 15 facets..4
4. Wing pads only extending to anterior of second abdominal segment; eye with about 20 facets (fig. 8E)..... *4th instar*
   Wing pads extending to fifth abdominal segment; eye with over 40 facets (fig. 8F) ..... *5th instar*

Larval structures

Eyes

The lateral eyes of Tingid larvae differ from those of the larvae of most hemimetabolous insects, for at the time of hatching they consist of five separate facets. After the second instar this number increases (Roonwal, 1952) and the new facets develop so that the eye of the adult resembles the normal compound eye. The additional facets become visible adjacent to the original facets as their pigment develops during the first few hours after ecdysis; this is most clearly seen in the third instar (figs. 8B-D).

Glandular Hairs

These are long more or less club-shaped unbranched hairs found in the larvae of *T. ampliata*. In the first instar they have a sticky globule at their apex (fig. 9A) and are longest (0·04 mm.) on the antennae. In later instars these hairs are shorter, club-shaped (figs. 9B and C) or trumpet-shaped (fig. 9D). Similar hairs have been described from the larva of *Stephanitis rhododendri* Horv. (Johnson, 1936).

In teneral insects of the later instars of *T. ampliata* the simple hairs bear globules at their apex. These globules disappear when the insect is immersed in cold chloroform. The globules have not been seen to increase or decrease

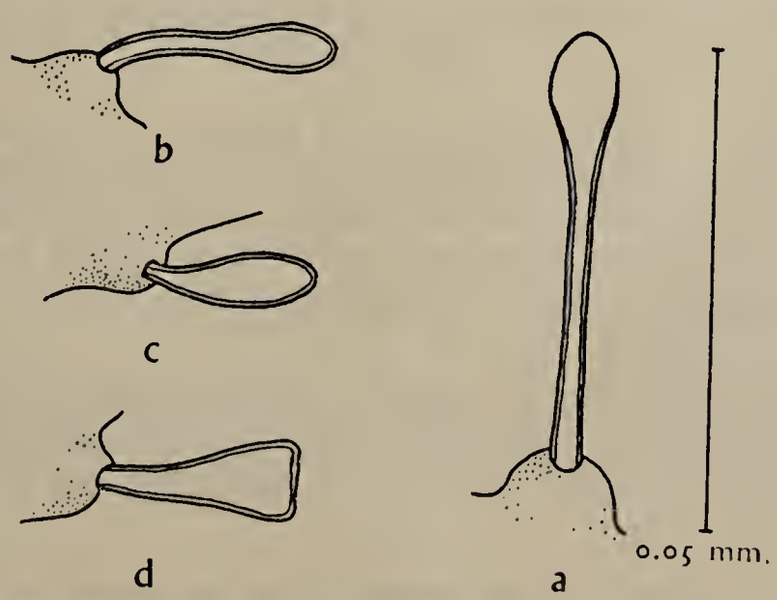

Fig. 9. *T. ampliata*, glandular hairs of larvae: *a*, from head spine of first instar; *b*, from antennae of fourth instar; *c* and *d*, from head of fourth instar.

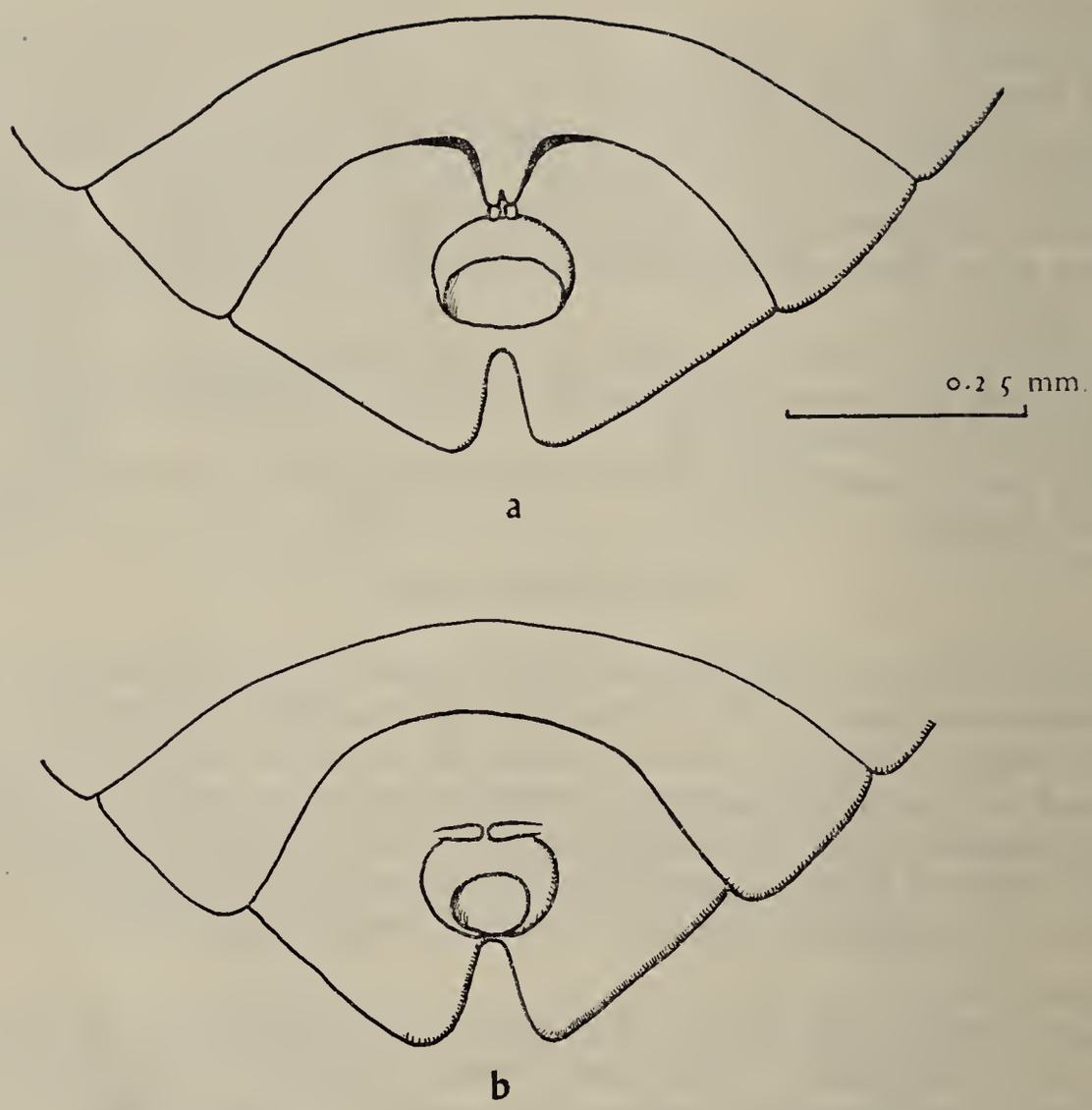

Fig. 10. *T. ampliata*, fourth instar larva, ventral view of posterior of abdomen: *a*, female; *b*, male.

in size as was noticed by Johnson in *S. rhododendri*, but there was considerable variation in the size of the globule of comparable hairs in different individuals.

External Sex Organs

Dupuis (1947) gives a resume of the literature on the separation of the sexes in Heteropterous larvae, but the Tingidae do not appear to have been studied in this respect.

The two sexes in the fourth and fifth instar larvae of both *T. ampliata* and *T. cardui* are readily distinguished. In the male (figs. 10B, 11B), the rudiments of the parameres are discernable; whilst in the female (figs. 10A, 11A) the rudiments of the ovipositor can be seen arising from the posterior margin of the eighth and from the ninth segment.

Dorsal Abdominal Glands

Gulde (1902) pointed out the presence of two dorsal abdominal glands in *Tingis*. These consist of two sac-like structures opening at the posterior margins of segments 3 and 4 (fig. 12). In the living bug they are orange.

Wax

Hitherto the secretion of wax granules in the terrestrial Heteroptera has been demonstrated only in the Pentatomidae (Butler, 1923; Leston, 1953; Jordan, 1953) and the Reduviidae (Miller, 1953).

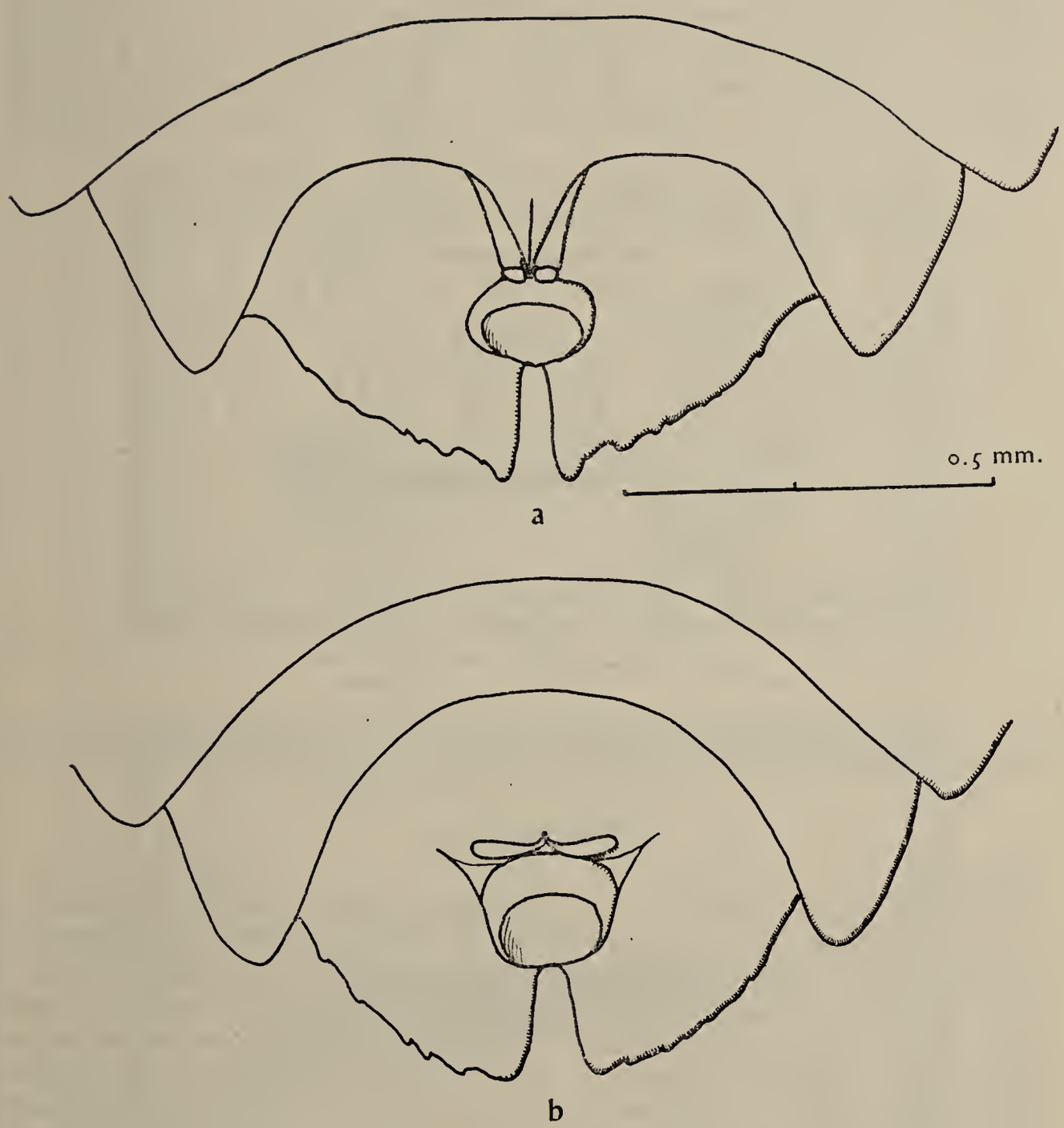

Fig. 11. *T. ampliata*, fifth instar larva, ventral view of posterior of abdomen: *a*, female; *b*, male.

In the adults of *Tingis ampliata* and *T. cardui* wax is present in the form of granular filaments, Saunder's (1892) "sort of woolly white pubescence." This dissolves readily in cold chloroform and when the solution is evaporated the wax remains as a thin smooth layer.

Wax was not present on teneral adults; their surface is shining and chloroform in which teneral individuals had been soaked left no deposit on evaporation. Adults a few hours old appear dull and wax is present on most parts of the body being especially noticeable on the posterior dorsum of the head, the thoracic keels and on the lateral regions of the abdominal sternites.

Deposits of wax have been demonstrated on the fourth and fifth instar larvae of both species, occurring particularly around the glandular hairs.

Surface wax also occurs in other Tingidae; in *Serenthia laeta* it imparts a bluish tinge to the black regions; whilst in *Lasiocampa capucina* it gives the bug, which is in reality brown, a whitish coloration.

Fig. 12. *T. ampliata*, fourth instar larva, ventral view of dorsum of exuviae, showing dorsal abdominal glands.

Distribution

Geographical

Both species are confined to the Palearctic region which corresponds to the natural range of their host plants; however, although *C. arvense* is if anything more widely distributed than *C. vulgare* (Clapham, Tutin & Warburg, 1952), *T. ampliata* (fig. 13A) is not as widely distributed as *T. cardui* (fig. 13B). *T. cardui* extends further south and north, it also occurs on various islands, e.g., Giglio Il. (Mancini, 1952), Jersey, Channel Ils. (Le Quesne, 1953); from which *T. ampliata* is absent. According to catalogues the latter has not been recorded from Poland, but Lomnicki's (1881) record for this country appears to have been overlooked.

These differences in range probably reflect differences in climatic requirements between the two species. However the absence of *T. ampliata* from suction trap catches (see p. 102) suggests that its flight is limited and this may be a contributory factor in the restriction of the distribution of this species, e.g., its absence from Jersey. It is interesting to note that the host plant of *T. ampliata* is a perennial; therefore if the bugs hibernate near it, the colony can be re-established in the spring without widespread dispersal. On the other hand *C. vulgare* and *Carduus* species (which are probably more important as host plants in Asia than in Britain) are biennials and hence *T. cardui* will have to find a new plant after hibernation, its "parent" plant being dead.

On the Host Plant

It has been shown the eggs of *T. ampliata* are laid in the stems of the host plant and when an early stage larva it occurs on the vegetative buds;

as a later larva (5th instar) or an adult it is found on the stems and leaves, but never on the involucre. In contrast *T. cardui* lays its eggs in the leaves and as a larva it is confined to the involucre and the region just below. Thus even if both species were present on the same plant (e.g., *Cirsium palustre*) their populations would remain separate. This type of habitat

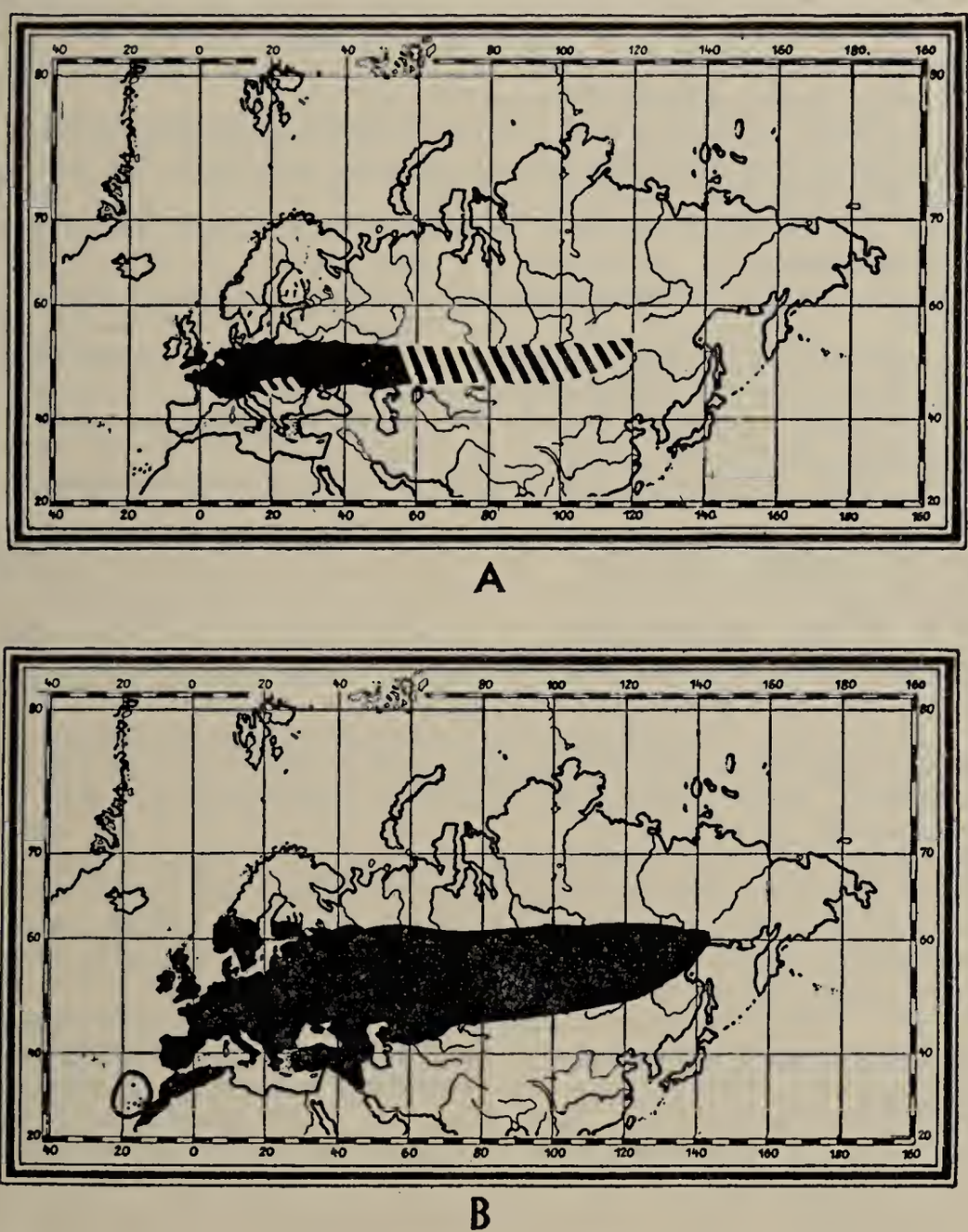

Fig. 13. Map A, Distribution of *T. ampliata*. B, Distribution of *T. cardui*.

isolation in phytophagous insects does not seem to have been previously observed (Allee et al 1949).

However the two lace bugs normally occur on different species of thistle; *T. cardui* on *Carduus* sp. and *Cirsium vulgare*, *T. ampliata* on *C. arvense*; this represents the more widely found type of habitat isolation.

Both species are included in the same subgenus, *Tingis*, but it must be stressed that they are easily distinguished and cannot be considered as closely related species in Diver's (1940) sense. The factors that originally lead to speciation are most likely to have been different from those that now keep the populations separate.

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